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Development, Testing, and Evaluation of
Visual Landing Aids

Consolidated Progress Report
to the

Airborne Equipment Division
Bureau of Aeronautics
Department of the Navy

For the Period
July 1 to September 30, 1955

for
Bureau of Aeronautics Projects

TED No. NBS-AE-10002

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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Development, Testing, and Evaluation of
Visual Landing Aids

July 1 to September 30, 1955

I. REPORTS ISSUED

<u>Report No.</u>	<u>Title</u>
21P-11/55	Photometric Tests of a Modified High-Intensity Deck-Surface Light
4219	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for the Period April 1 to June 30, 1955

II. RESEARCH AND DEVELOPMENT, LABORATORY TESTING, AND CONSULTATION SERVICES IN CONNECTION WITH VISIBILITY, AIRFIELD LIGHTING, AND FOG MODIFICATION PROBLEMS. (TED NBS-AE-10002).

a. Visibility Meters and Their Application.

Transmissometers. One complete transmissometer and two additional indicators have been sent to NAS Atlantic City. A visit was made to the station and the transmissometer in the touchdown area was adjusted and placed in operation.

Phototubes of improved construction have been received from the Continental Electric Company and tested. The results were quite satisfactory. These tubes have a cathode area about one-half that of the type now used and the anode structure has been moved to the sides of the tube so that the image of the projector does not fall on it. Efforts are now being made to obtain tubes of this construction but with a photosensitive surface with spectral response characteristics which more nearly approximate the spectral response characteristics of the human eye.

Individual phototubes and trigger tubes are now tested by giving them an operational check. Since the tests of this type are not applicable to specifications or routine inspection, a study is being made of direct methods of testing the tubes using quantitative measurements. A sufficient number of tubes have been evaluated to permit the preparation of a performance specification.

The list of pen and ink changes and the change sheets to be used in modifying copies of the original instruction manual to conform to the revised manual have been completed and are now being reproduced.

A report giving an analysis of the theory of the photometric system of the transmissometer is being prepared. The intent of this report is to assist personnel responsible for the design of installations and for the application of instruments by providing a more complete theoretical background than was possible to include in the instruction manual.

Brightness Meters. Two sets of photoelectric sky-brightness meters and illuminometers have been calibrated and tested. The scanning driver caused some difficulty because of weaknesses in the gear boxes. These were rebuilt. After satisfactory operation was obtained, these meters were shipped to the Arcata Field Laboratory.

b. Airfield Lighting and Marking.

Runway Marking. A comprehensive program for the evaluation of paints and other materials intended for use as runway markings has been developed and coordinated with the various groups within the Bureau which will do the testing.

Taxiway Lighting. Intensity distribution measurements have been made of a type M-1 light with a clear asymmetric and with a blue symmetric lens. A report has been prepared.

Fueling Lane Lighting. A report giving the results of intensity distribution measurements of a Doane high-intensity deck-surface light and an analysis of these measurements has been completed and released. (NBS Report 21P-11/55)

Control of Constant-Current Regulators. To prevent failure of all lamps in a series circuit as lamps fail and the output current rises, a safety circuit which will put constant current regulators on brightness step 4 when the current on step 5 would exceed 6.8 amperes has been designed and the necessary controls ordered. The system will be tested at Arcata.

Heliport Lighting. An approach-angle light has been received from Forway Industries Inc. It is scheduled for tests starting October 17.

c. Seadrome Lighting.

Norfolk Installation. Assistance has been given representatives of the Visual Landing Aids Section in the planning of a seadrome lighting system for NAS, Norfolk. Efforts are being made to obtain 20-ampere, 500-watt, series-burning lights for this purpose. These lights would have a beam pattern similar to that of the 350 PAR and 399 PAR approach light lamps.

Development of High-Intensity Seadrome Lights. The principal tasks under this project are two aspects of the problem of improving seadrome lights; the development of an optical system for cable-fed seadrome lights, and the development of a circuit for battery-operated buoy lights which may be turned on or off by a single pulse, probably through use of a polarized relay. For this latter task the components of four seadrome lights are now on hand but no laboratory work has been started.

The problem of the cable-fed buoy light has been discussed with the engineers of the Bureau of Aeronautics and it has been decided that the first design should aim at an aviation green light of not over 500 watts consumption. A study of mercury lamps is under way. Such lamps have high efficiencies in lumens per watt and the light is greenish in color. A filter has been found which will correct the mercury light to conform with the definition of aviation green and the transmission of this filter for mercury light is now being computed. This problem has also been discussed with an engineer of the General Electric Co., who has indicated that it may be possible to increase the efficiency of mercury lamps in this application by the use of a frequency of about 500 cycles per second.

d. Carrier Lighting.

The equipment for controlling the wave-off lights of the mirror landing aids system has been received and assembled for test. These tests revealed that the action of the mercury relays intended to flash the wave-off lights was too slow because of the incorporation of vibration dampers in these relays. Relays without vibration dampers have been ordered. A visit was made to the U.S.S. Bennington and details of the wave-off system were discussed. Following these discussions the control circuitry was revised to adapt it to the other circuitry now on the mirror system. Two sets of the control equipment will be wired and shipped to the Bennington as soon as the new relays are received. On numerous occasions technical advice and assistance has been given to representatives of the Navy and

of contractors in the design of improvements to the mirror landing aids systems.

e. Lighted Suit for Landing Signal Officer.

Braided wire for the light strips on the LSO lighted suit equipment has been investigated. It is expected that the strips will be fabricated as extruded plastic with the braid imbedded inside. Reports from users of the Model O equipment indicate that failure of the braided wire within the rubber strips has been more of a problem than was anticipated. Accordingly various samples of braid have been life tested on a flexing machine, and it was ascertained that a braid consisting of about 150 strands of No. 40 gauge wire should provide durability superior to the coarser braid used on the Model O equipment, but that the strips will nevertheless have limited life.

A specification is in preparation for use in procurement of the new equipment. If a loose specification will be adequate, then the specification will be completed in about 6 - 8 weeks. If a tight specification is required, then several months will be necessary to resolve several questions relating to the design of some of the components of the equipment. The decision as to which kind of specification will be required is to be made by the Bureau of Aeronautics within 1 - 2 weeks.

f. General Laboratory and Consultive Services.

Specific Intensity Measurements of Retroreflectors. Measurements of the specific intensity of a group of colored retroreflectors have been checked. A report giving the results of specific intensity measurements of 21 colored retroreflective samples has been completed and is being prepared for reproduction.

Cable Test-Detecting Set. The laboratory tests of this unit have been completed and the set has been sent to the Arcata Field Laboratory.

Kinorama. The following persons have inspected the kinorama:

Col. H. J. Holt and Col. A. J. Hill of the Military Agency for Standardization. Arrangements for the use of the kinorama for intercomparing approach-light configurations in connection with an Air Force-Civil standardization are under consideration.

Lieut. R. Gross of Wright Air Development Center. The kinorama was considered as a training device for Air Force pilots. It will not be used under their present contracts.

Dr. C. P. Seitz and Dr. H. A. Voss of the Naval Special Devices Center. The use of the kinorama for a general study of approach-light configurations is being studied.

Mr. R. P. Snodgrass, Engineering Department Head for Flight Research at the Sperry Gyroscope Co. The use of the kinorama for flight research was considered. There was a generally favorable reaction but no specific proposals.

Col. J. F. Taylor, Director of the Air Navigation Board, flew the kinorama to become acquainted with the possibilities of the device. Further demonstrations have been requested.

III. VISIBILITY AND BRIGHTNESS TESTS, SURVEYS, EVALUATION AND ANALYSIS OF VISUAL LANDING AIDS, BASIC TESTS AND EQUIPMENT AS A FIELD SERVICE AT ARCATA, CALIFORNIA (TED NBS-AE-10011).

a. Airport Lighting and Marking.

Approach Beacons. Arrangements have been made to obtain the assistance of CAA maintenance and flight test personnel in checking the effects of the approach beacon to be installed at the end of runway 13 as part of a stub approach beacon system on the localizer of the ILS system. Because of the bluff in this area, it will be necessary to mount the approach beacon only 75 feet from the localizer. Preliminary checks showed that there was interference with the localizer beam pattern. Since problems similar to this are expected at other airports, this work will be of general rather than only local value. Southwest Airways and the Humboldt County Department of Airports are considering installation of a standard approach-beacon system at Crescent City as a result of their experience with the experimental system at Arcata. The installation will provide more pertinent flight data than the Arcata installation since there is no approach-lighting or instrument-landing system at Crescent City. Five beacon bases have been obtained from the CAA and the other fixtures necessary for test installations at Arcata have been obtained.

Airfield Lighting Maintenance Manual. The step-by-step trouble-shooting procedure and the trouble-shooting charts have been revised and are now being put in final form. The section on general trouble-shooting procedures for series and parallel circuits has been outlined. The first draft of the part covering series circuits is nearly complete. This section is intended to give the general and detailed information needed for trouble shooting so that a minimum of text and detail is required in the step-by-step procedures.

Regulators. Three type NC-3 regulators have been obtained from Navy stock and installed in the runway lighting circuits. These regulators will be used for tests of over-current protective devices, studies of optimum intensity of runway lights, etc.

b. Electrical Engineering.

Cable-Fault Finding. The TSM-11 Test Set has been received and is being tested. A number of problems have been found in the application of the instrument to circuits having multiple grounds, lines in sheath or duct buried in soil of poor conductivity, and lines of varying depth. These problems are inherent in the use of any instrument operating on the same principles as the TSM-11. Methods of using the set under these conditions will be developed and notes to be added to the instructions for using the instrument will be prepared.

Induced Voltages. A study is being made of the effects of induced voltages in control cables using the cables to the slant visibility meter for the tests. Considerable difficulty in the operation of relays was encountered because of strong voltages on this cable. The relay coils were shunted with lamps or resistors to obtain satisfactory operation. Use of incandescent lamps is particularly advantageous since they present a low shunt resistance to the stray voltages, since these do not heat the filament to incandescence, and a much higher resistance to the control voltages, since the lamps are then hot.

With this cable completely disconnected, some stray voltages were present. When some of the conductors are connected to the equipment, the voltages are increased. Checks are now being made to see what part of these stray voltages result from leakage between conductors and what part is the result of capacitive or inductive coupling.

c. Research on Visibility Measurements and Visibility.

Sky Brightness. The sky brightness meters and illuminometers have been received from Washington. Tentative sites and plans for the needed control and signal cables have been determined. It is planned to install the two sets about 3000 feet north and 3000 feet south of the laboratory and to put all the recording instruments in the laboratory. A concrete pier has been constructed in the laboratory to provide a stable, vibrationless support for the self-balancing potentiometers.

Slant Visibility Meter. A recording amplifier which will operate a 5 ma Esterline-Angus recorder was designed, constructed, and calibrated in Washington and has been installed to record the ceilometer output. The instrument is operating satisfactorily. The sensitivity is very high and the stability is very satisfactory. Some modifications have been made in the circuitry of the scanning drive and the reversing switch in the scan-drive motor has been replaced with external relays to protect the starter winding of this motor. The projector lamp life has been quite variable. Some lamps last weeks, others only a few days.

Transmissometry. Considerable data have been obtained on the magnitude of the error produced by light from the projector being scattered into the receiver. Measurements have been made in fogs with transmissions as low as 0.0007, using a receiver aperture of 3.5 inches. An error of about 0.0002 was found in this fog. The error is about 0.001 when the transmission is 0.1, 0.0005 when the transmission is 0.01, and 0.0002 when the transmission is 0.001. None of these errors has a significant effect on the indicated visual range. Measurements are now being made with a receiver aperture of 2.5 inches.

Equivalent Intensity of Flashing Lights and of Composite Units. Reports giving the results of measurements of the effective intensity of a Sylvania Strobeacon and a composite unit are now nearly complete. Plans are being made to study the effective intensity of a Westinghouse Krypton light. The unit has been checked and found to be inoperative because of either a defective igniter coil or lamp.

Facilities. Most of the present overhead circuits between the control tower and the vault have been transferred to the new underground cable which was installed when the CAA was installing cables between these points. This addition provides sufficient cable for some expansion and provides access to the controls of the visual aids at the field.

